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Surface origin of quasi-2D Shubnikov–de Haas oscillations in Bi2Te2Se

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Abstract

© 2015, Pleiades Publishing, Inc. Transport measurements at liquid helium temperatures were done on a number of Bi2Te2Se samples with thicknesses ranging from 30 to 200 μm in order to detect surface states. In each sample we observed Shubnikov–de Haas (SdH) oscillations and sublinear dependence of off-diagonal component of magnetoresistance tensor on magnetic field. The periods of SdH oscillations in inverse magnetic field were found to be the same within 15%. The positions of SdH oscillations are determined by the normal to surface component of magnetic field. We found that the measured conductivity can be well described by a model with two groups of electrons, 2D and 3D. The conductivity of 2D electrons was found to be relatively weakly varying from sample to sample and not depending on thickness in a systematic manner. This behavior can be explained only by their localization on the surface. Comparison of the results of magnetotransport measurements with our scanning tunneling spectroscopy results on atomically smooth Bi2Te2Se surface in ultrahigh vacuum led us to conclude that the surface electrons are separated from the bulk electrons by a depletion layer approximately 100 nm thick. This effect could provide the dominant contribution of surface electrons to conductivity in samples with thicknesses less than 200 nm.

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